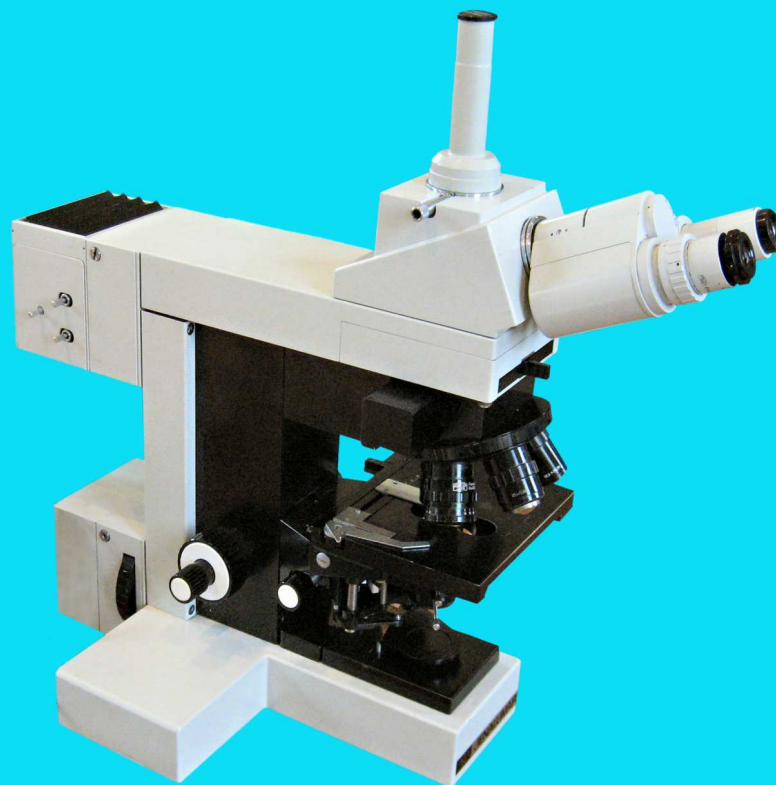


# A Practical Guide to Binocular Collimation



By  
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Author

Many years ago, in the mid 1990's I received a phone call from a member of a Microscopical Society who was an acquaintance of mine; it was a plea for help, "Ron... a friend is in dire straits, he has given his binocular head a very bad knock putting it out of collimation. As you have recently offered assistance in our 'Sales and Wants' can you help him?" After a brief exchange I said that I would, so the following Sunday saw my tools and I travelling to the outskirts of a small local town to meet the troubled microscopist.

Knocking on his door I was greeted by an old age pensioner who appeared to be in a state of stress; he told me he lived on his own, and his only enjoyment was his beloved microscopy. It was also obvious that he had seen better times, for his microscope was a very expensive piece of kit. He told me he had contacted the manufacturer about his binocular head, but the price quoted was far beyond his present means.

On examining the head, I found the prisms were still intact and in place, but at the base of one eyepiece tube was a 'scuff' mark and its mount appeared to have moved slightly under impact. On a scale of difficulty its collimation would be called "A Now't Job" in Yorkshire and, with the type of microscope he had, the time taken would be less than a couple of minutes. So to have a little fun I asked the gentleman for a cup of coffee or tea while I worked.

When he returned a few minutes later he saw my closed toolbox and his face dropped, "tis beyond repair then" he said, "No, it's back in commission" I replied with a grin. In disbelief he sat at his microscope and the tension that had gripped him since I arrived drained away. Taking my leave after refusing payment (I owed his friend a favour), I was pleasantly surprised the following week, to receive a nice box of slides in the post from him.

My point of writing this practical guide on collimation is to help amateur microscopists who may one day find themselves in similar traumatic circumstances to the above, and in response to a number of kind requests from members of the PMS and Manchester society. Unfortunately, today we live in a country with very little optical expertise, our 'Great Microscope Houses' which in times past provided a pool of skilled Service Engineers are

alas no more; as a result microscopists are often thrown on their own resources when their microscopes require collimation. A more mundane factor of course is cost; third party charges for head collimation can be quite astronomical and in some cases can run to three or four figures, yet the adjustment of binocular collimation is not some mystic art practised by modern day Wizards, any microscopist with common sense and simple equipment can do it. A little basic background information on collimation errors may not come amiss.

The three main errors of collimation are Dipvergence, Divergence, and Convergence. Figure 1 shows only dipvergence, (enforced Hyperphoria of one eye) as divergence and convergence are self-explanatory. These faults are undesirable deviations of the optical axes in a binocular microscope, which can occur if the microscope is subject to physical shock, user interference, or just plain old-fashioned wear and tear. Furthermore, such errors are relevant to microscopes with either convergent or parallel eyepiece tubes; fortunately, the image at the point of focus, as represented in Figure 3, is correct for both types when in collimation.

Another less common error; is rotation of an optical axis as it passes through a prism which has been disturbed, known generally as Prism rotation (see Figure 2) it is mostly found in binocular heads that use three point fixing of the prism mounts. Furthermore, this is usually caused by the user/owner attempting to adjust the collimation without the necessary knowledge or means of checking their work.

One common question I am often asked is “How can one tell if any collimation errors exist in a microscope?”... Well, one test experts recommended is to focus on the edge of a glass slide, then slowly withdraw one’s head from the microscope eyepieces until the single image separates into two. The line formed by the edge of the slide must continue to be straight through both eyepieces. Any errors such as dipvergence or prism rotation will appear as in Figures 1 and 2. Unfortunately, this test is of no value in detecting divergence or convergence. In addition, if any error exists in the vertical location of the testers eyes, (One or two millimetres is not uncommon), this will almost certainly void the check for dipvergence.

A far better test is one that I use after working on a microscopes collimation; it makes use of a spread slide of Deep Sea Soundings, although

any slide of fine Sand or Foraminifera is suitable. How I use this will be explained later.

Another question asked is... “What is adjusted when recollimating a binocular head?”... The answer is, that in most microscopes one has the option of moving an eyepiece tube, prism, or a first-surface mirror; the first method [moving an eyepiece tube] is of course to be preferred as no error such as rotation of the optical axis is introduced.

Moving on, many independent Contract Service Engineers correct any problem of collimation on site, and you may adopt their method as described here (two axes qualified collimation). The collimation tools you require are surprisingly few; a 10x eyepiece with a cross-line graticule, a Centring slide with cross-lines, and of course a variety of screwdrivers, star drives, and small Allen (Hex) keys.

The procedure for adjusting the collimation of a binocular head is as follows:-

- Step 1.** With both eyepieces removed from the head, put a straight edge across the eyepiece tubes and adjust them to the same height (use a depth gauge on convergent tubes). Also set the interpupillary distance to 65 mm, as an average setting will balance out any wear, in addition it is of benefit to Siedentopf heads as it can help reduce their collimation ‘run out’.
- Step 2.** Put the 10x eyepiece (with cross-line graticule) into the left hand eyepiece tube.
- Step 3.** Place the Centring slide on the stage, then select the 10x objective and bring the slide cross-lines to focus.
- Step 4.** Now with the mechanical stage adjust the position of the Centring slide cross-lines, until they appear to contact the eyepiece cross-lines as in Figure 3. Note, do not superimpose

the eyepiece cross-lines ... we require greater accuracy than the thickness of most Centring slide cross-lines (as seen at 100x).

**Step 5.** Next, remove the 10x eyepiece and put it in the right hand eyepiece tube, ensuring the eyepiece orientation is the same, (my eyepiece has a pointer that indicates the 180-degree position of the graticule). Additionally do not disturb the adjustments you have made previously.

**Step 6.** Looking through the eyepiece you will now see any error of collimation, for it is immediately apparent in the relative position of the two sets of cross lines.

Repeat steps 1 to 6 until you are quite satisfied that the error you see is not false, then take a piece of paper, and draw what you see through the eyepiece, try and be as accurate as possible. This is done purely as a safeguard in case of problems and you need to go back to your starting position. When you have completed the above record move on to Step 7.

**Step 7.** Now the right hand eyepiece tube, prism or mirror, after first slackening off the retaining screws, may be moved into collimation, constantly checking progress through the 10x eyepiece as the adjustment is made. When collimation is achieved the result should appear identical to Figure 3 in both eyepiece tubes.

Please note: the collimation of many binocular heads can be adjusted from either side but, for the sake of convention, I have chosen the right side. If you are left-handed, you may change the start procedure, commence with the right eyepiece, and adjust the left eyepiece tube or prism... However, with some heads such as the Lomo Ay-12 the left eyepiece tube is the only one that can be adjusted. Likewise, mirror type heads also have restrictions i.e. adjustment is on the right side. Also, please keep in mind the aim is to only 'tweak' the settings, and not cause major disruption to the optical system. Furthermore the method described, although adequate for use in the 'field', cannot compare with the ease of using an optical collimator, but then again neither can the cost, a collimator can run to many thousands of pounds (or dollars).

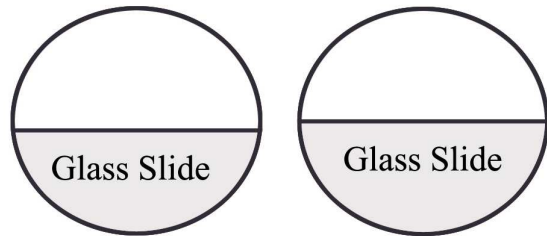


Figure 1.  
Dipvergence

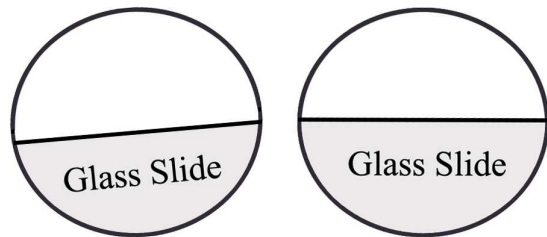


Figure 2.  
Prism Rotation

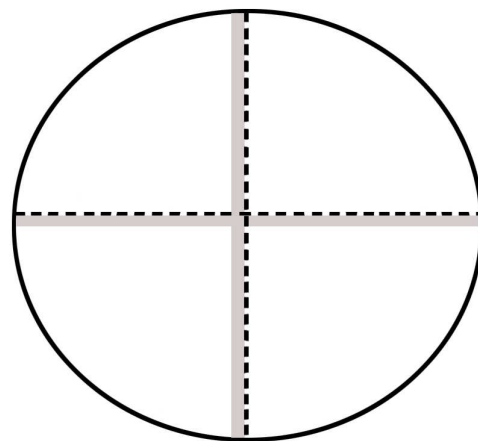


Figure 3.

----- Eyepiece  
Cross Lines  
  
—— Centring  
Slide  
Cross Lines

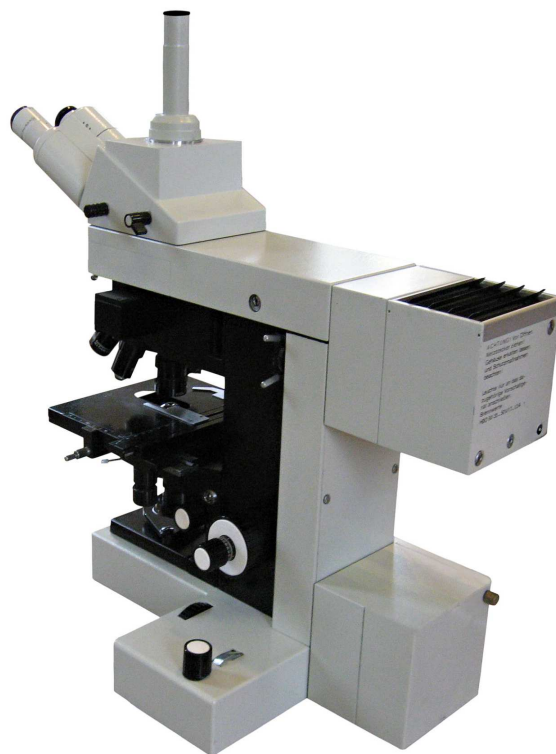
Image as seen in both eyepiece  
tubes when correctly Collimated



Before trying one's hand at adjusting collimation it is very important that due notice is taken of the following advice, for it will help prevent anyone 'getting out of their depth':-

1. Do not attempt to adjust the collimation of your binocular head without the necessary tools, although it may appear to be collimated it can still cause eyestrain. Small collimation errors can be 'insidious'.
2. Only adjust a Siedentopf prism as a last resort and only then when you are quite sure, the microscope manufacturer has not provided any other means.
3. If you have to adjust a prism or mirror to collimate, **do not move any others at that time**. If you fail to achieve collimation, see four below.
4. If after moving the eyepiece tube, prism or mirror you cannot achieve collimation return them to the starting position (refer to your record) then work on the other side of the binocular head.
5. Beware! Some manufacturers in the past have used shims under the prism-mounts.
6. When working on a binocular head, try not to use an excessive amount of adjustment on any one side, for this can lead to other problems of collimation.
7. When you have moved the eyepiece tube, prism, or mirror into position, be very careful re-tightening the screws; tighten each a little at a time constantly checking progress through the 10x eyepiece, as it is very easy to undo your work.
8. If when conducting the recommended slide test the images appear to have the same angle of prism rotation in both eyepiece tubes, the cause is unlikely to be the head. This condition is typical of an out-of-square mechanical stage.
9. Only undertake collimation if you are confident of your ability in matters mechanical, dexterity is the order of the day and any hand tremors are a "No No". If you have an old binocular head, practice on that to discover if this type of work is for you.

10. Last but not least use common sense **‘Don’t fix it if it’s not broken’** ... **you can make matters a lot worse.** This is especially the case with older microscopes, sometimes their original collimation left a lot to be desired.



The following photographs and advice are just a few selected examples to give those contemplating such work a source of reference:-

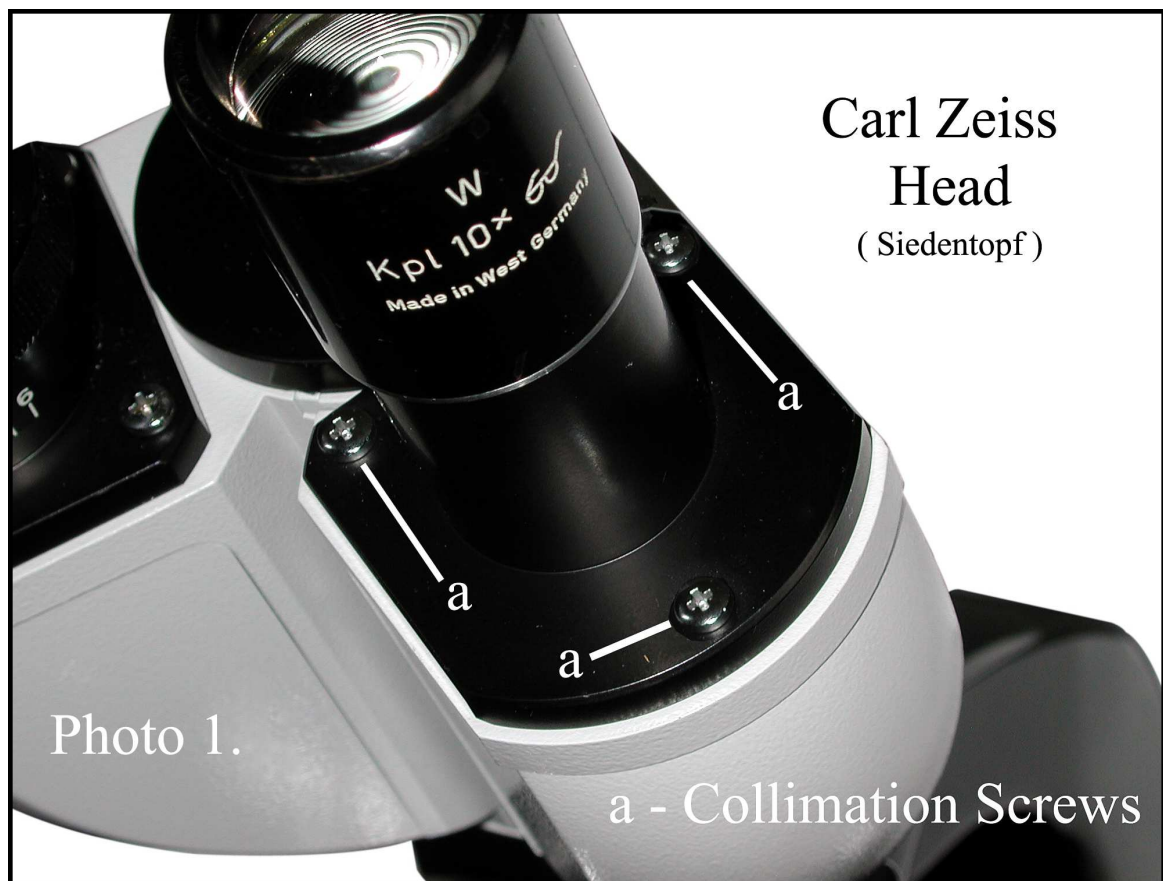
**Photo 1.**

Carl Zeiss Head ...Type Siedentopf.

Adjust right side eyepiece tube.

Comments. Slacken screws and slide eyepiece tube into collimation.

Difficulty level...Easy and straight forward.

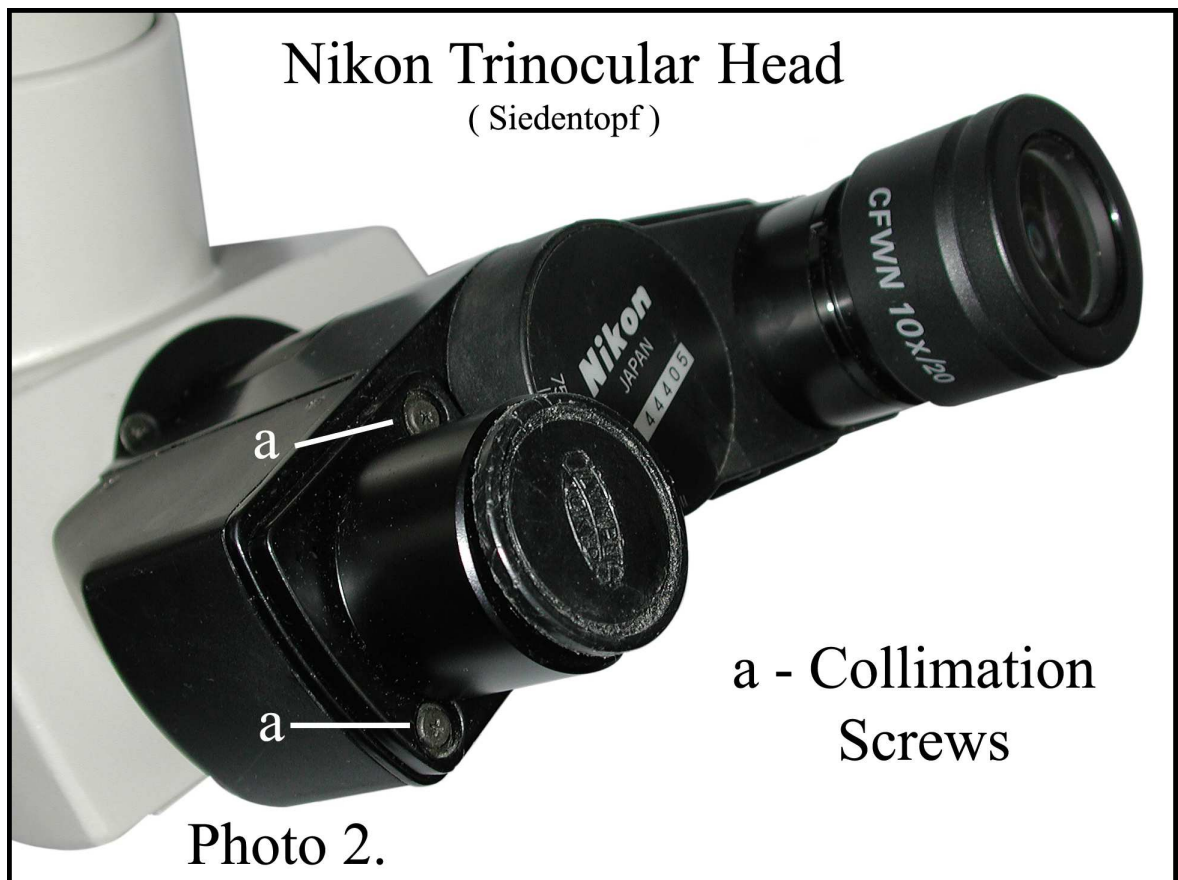


**Photo 2.**

Nikon Trinocular Head ...Type Siedentopf.

Adjust left eyepiece tube.

Comments. With this type of head the right eyepiece is rotated by a metal band under a fibre cover, so try to avoid working on the right or you may also have to adjust the said band as well. Note the two-collimation screws may be very tight and sealed with a drop of epoxy resin, so it is most important a good fitting screwdriver is used; as you may have to give it a short sharp rap to break the seal on each of the screws (not with a 7 lb hammer please). Difficulty level... Easy, but the above screws can make one's heart rate increase.



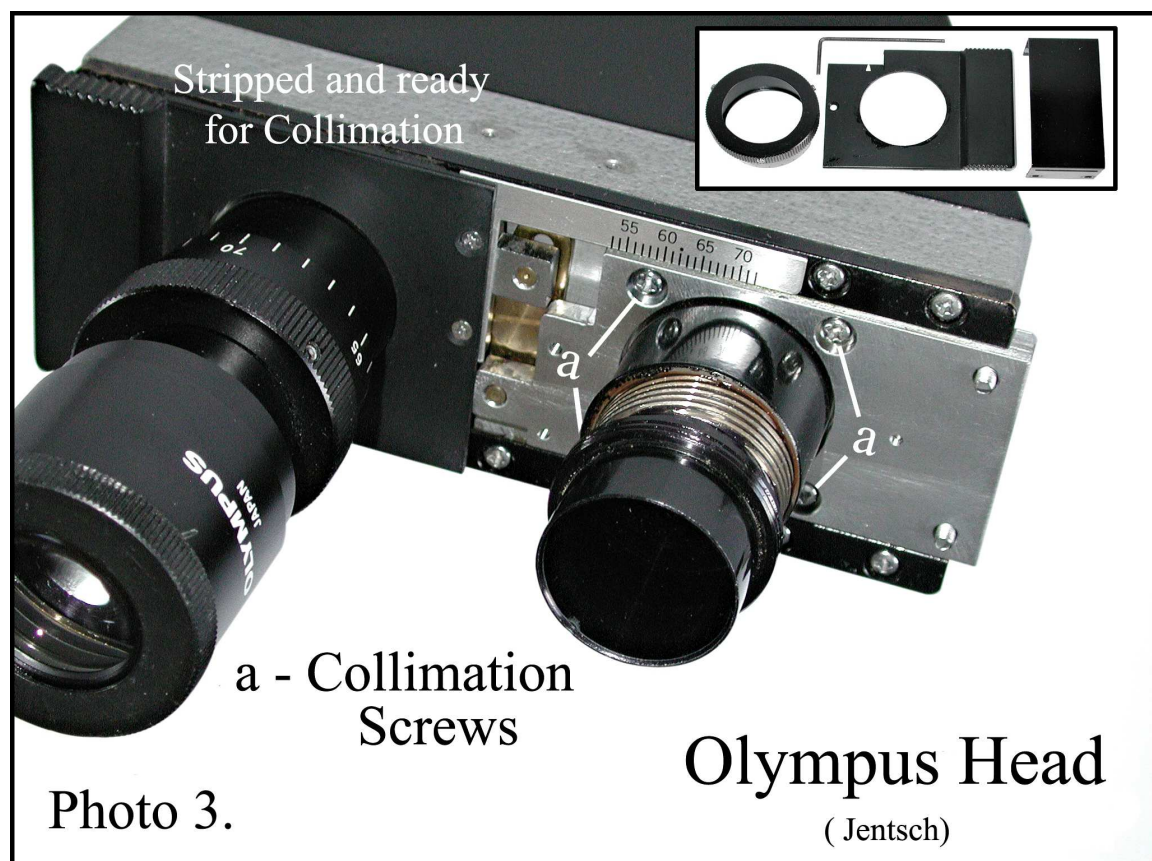
**Photo 3.**

Olympus Head...Type Jentsch.

Adjust right side eyepiece tube. (Prism underneath is attached to the tube)

Comments. First remove bridge plate between eyepiece tubes, and then remove focus ring of right eyepiece (grub screws require an Allen key). Next remove the right cover plate (one small screw on top and two underneath). The collimation adjusting screws (Four) are now revealed. When reassembling after collimation set the left eyepiece tube to say 65, adjust right tube with a straight edge to same height and set that eyepiece ring to 65 then tighten the screws, but make sure you have put the cover plate on first.

Difficulty level...Easy, but more work is involved.



**Photo 4.**

Gillett & Silbert Head...Type Siedentopf.

Adjust right side eyepiece tube.

Comments. This head is pure delight to work on; the bridge construction even provides good access for cleaning the prisms. A much-underrated design.

Difficulty level...Easy and straight forward.



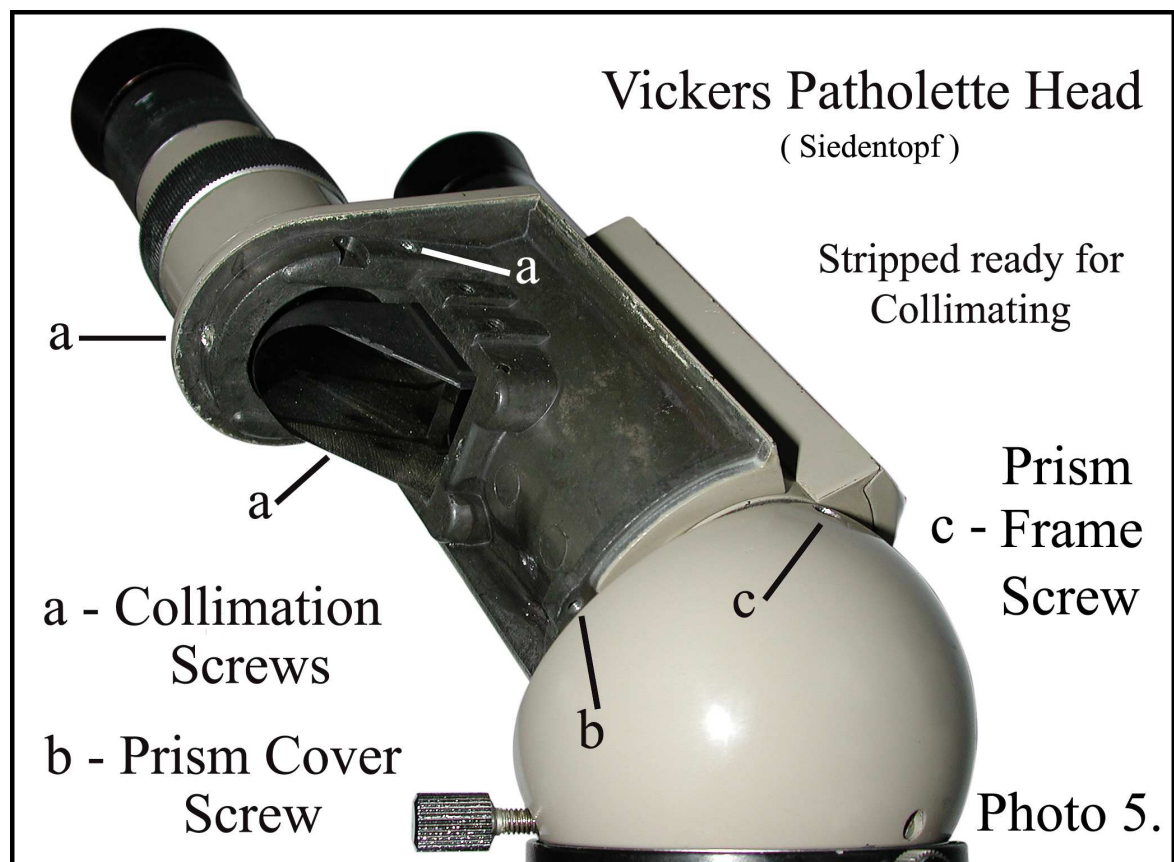
**Photo 5.**

Vickers (Patholette)...Type Siedentopf.

Adjust right side eyepiece tube.

Comments. Adjustment is by screws that bear on cone fittings, which are part of the eyepieces tubes. Slacken off screws (c) in ball housing and remove prism frame, at the base of the cover plates are counter sunk screws remove the right one (b) and slide the plate down, replace head assembly applying pressure to compress internal spring and fix with frame screw (c). The three adjustment screws (a) are below the top plate. Note the range of adjustment is limited before a collimation screw prevents the cover sliding back on.

Difficulty level...Not hard but more work what's more take care with the screwdriver do not damage the prism.



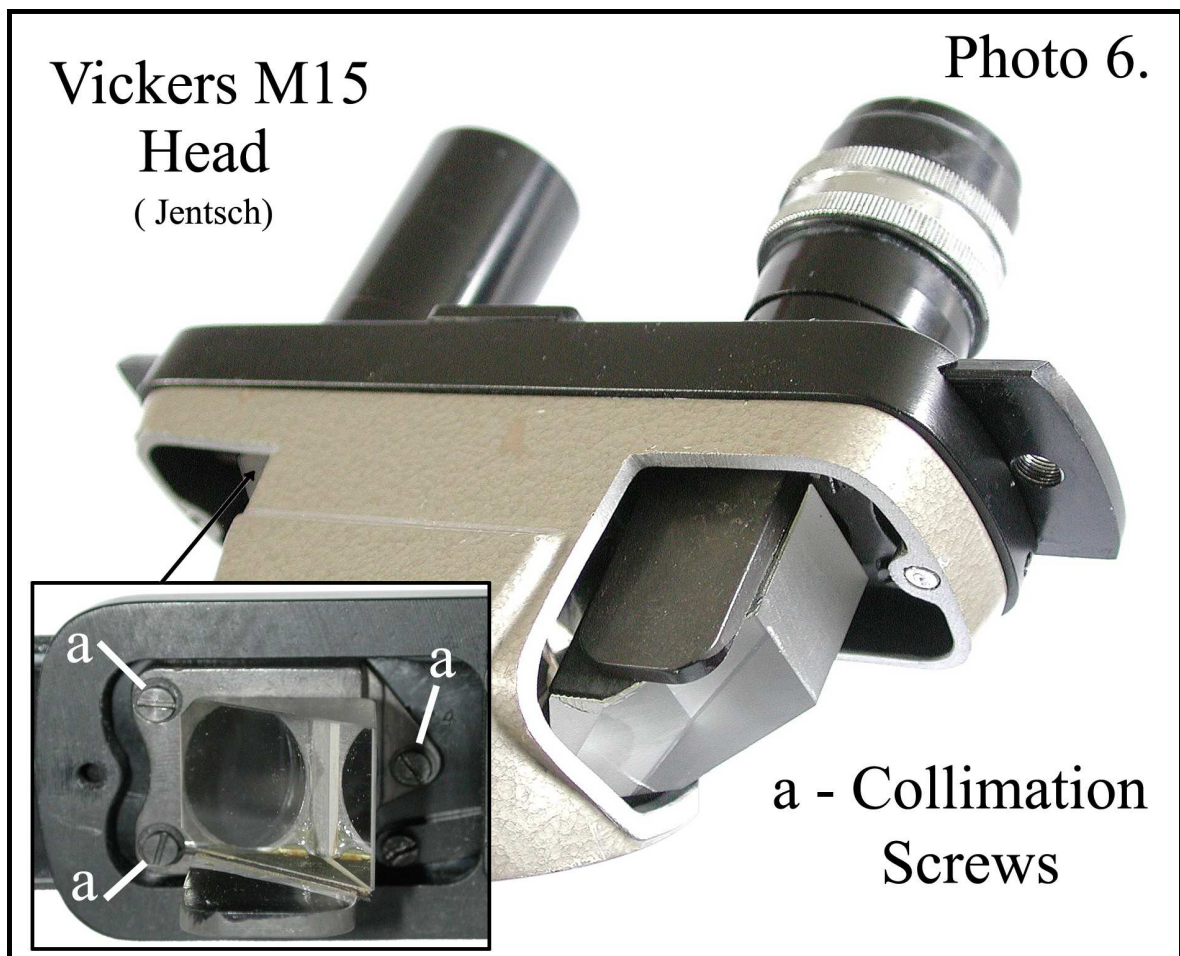
**Photo 6.**

Vickers M15 Head...Type Jentsch.

Adjustment by moving a prism...Adjust right side.

Comments. This head requires either a skeleton housing jig or two pillar screws to hold the head far enough away to adjust the selected prism.

Commence work by removing the two Chrome knobs, some models have flush fitting plugs which require a double pin tool to remove; next centre the holes in the top plates, and remove the left and right screws to release the prism assembly, there are three screws to each prism mount for adjusting the collimation, but again take care with the screwdriver do not damage the prisms.





Difficulty level...Can be a pain for the novice and the expert alike, a great deal of work is involved and at times can get quite frustrating, especially if it has been badly serviced by Mr. Fix-it. Also check the eyepiece slideways for wear; if you can rock the eyepiece tubes then collimation will be next to impossible. If you are still not put off and intend to proceed, be careful of prism rotation it is easily caused with the three point fixing. Furthermore, do not interfere with the centre Swan cube mount.

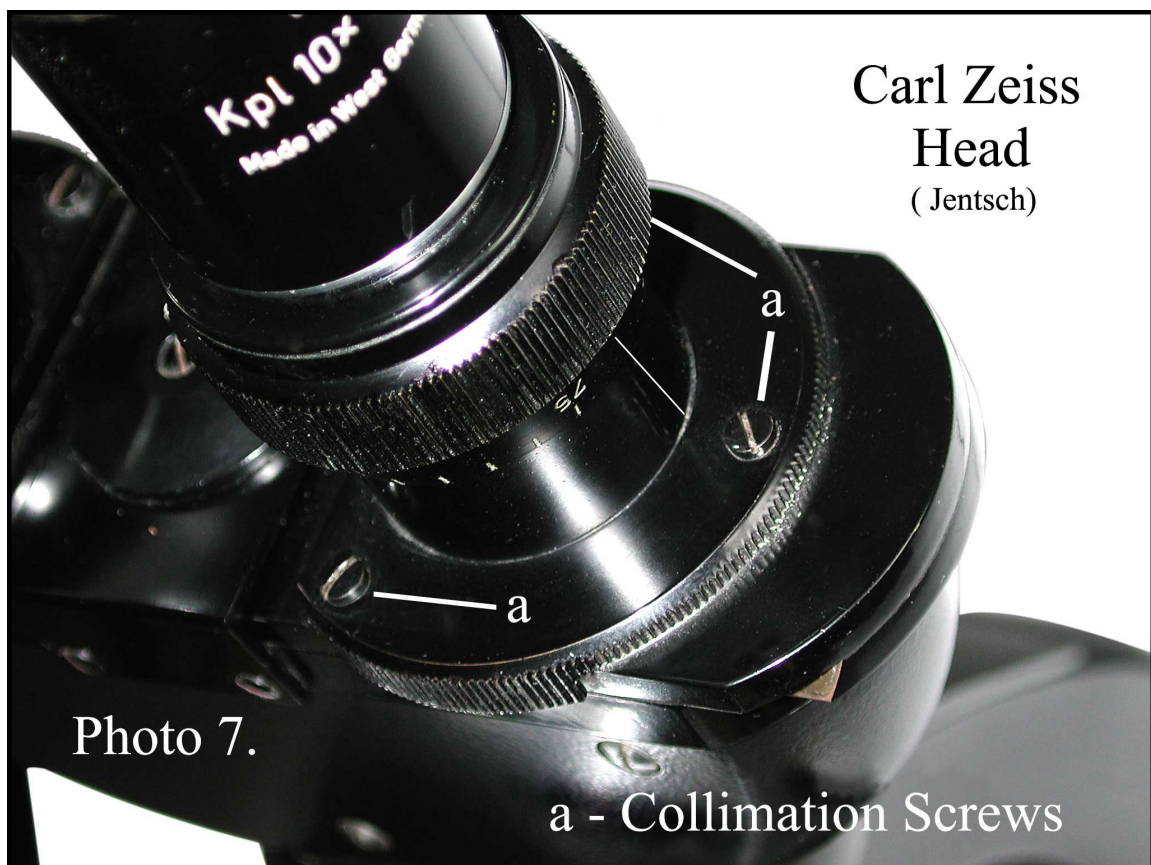
**Photo 7.**

Carl Zeiss Head...Type Jentsch.

Adjust right side eyepiece tube.

Comments. Slacken screws and slide eyepiece tube into collimation.

Difficulty level...Easy and straight forward.

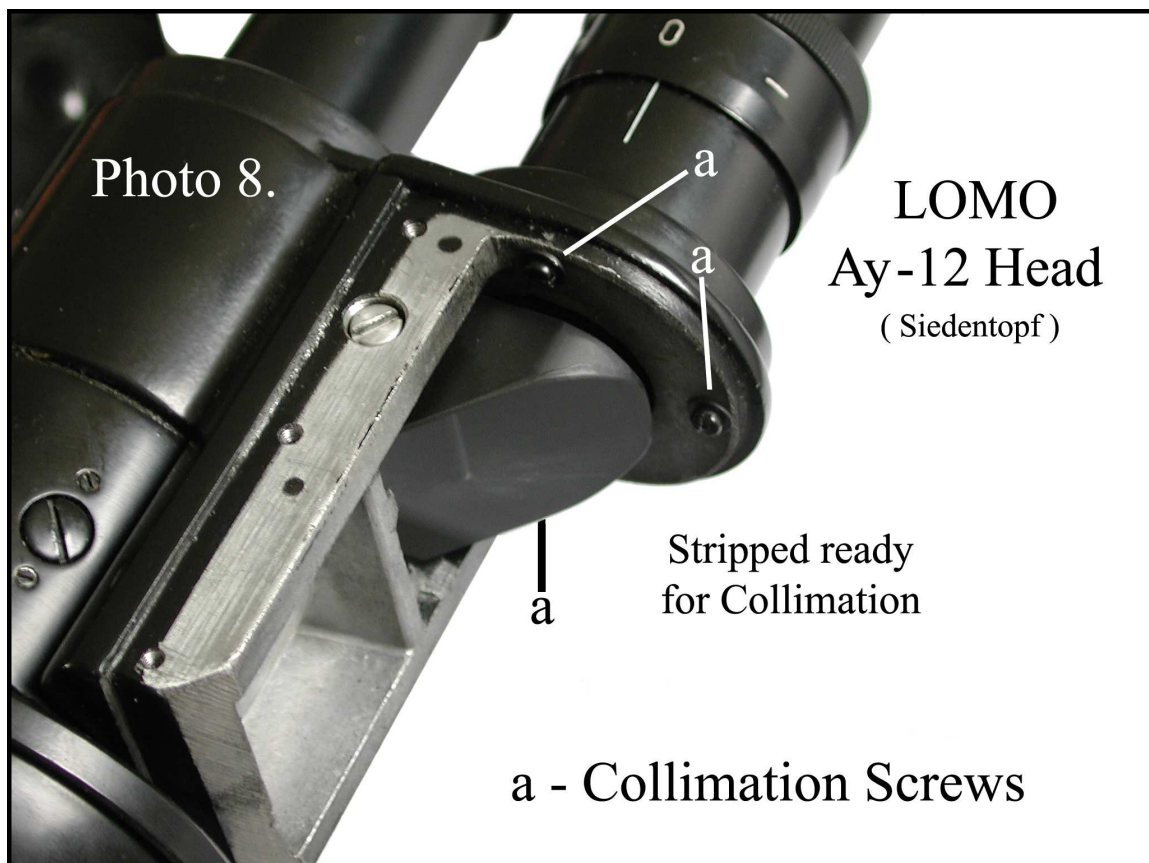


**Photo 8.**

Lomo Ay-12...Type Siedentopf.

Adjust left side eyepiece tube.

Comments. Remove six screws holding the left Prism cover, then slacken three screws (a) under top plate, and slide eyepiece tube into collimation. Difficulty level...Easy, Should present no problems but once again the warning is; take care with the screwdriver do not damage the prism.

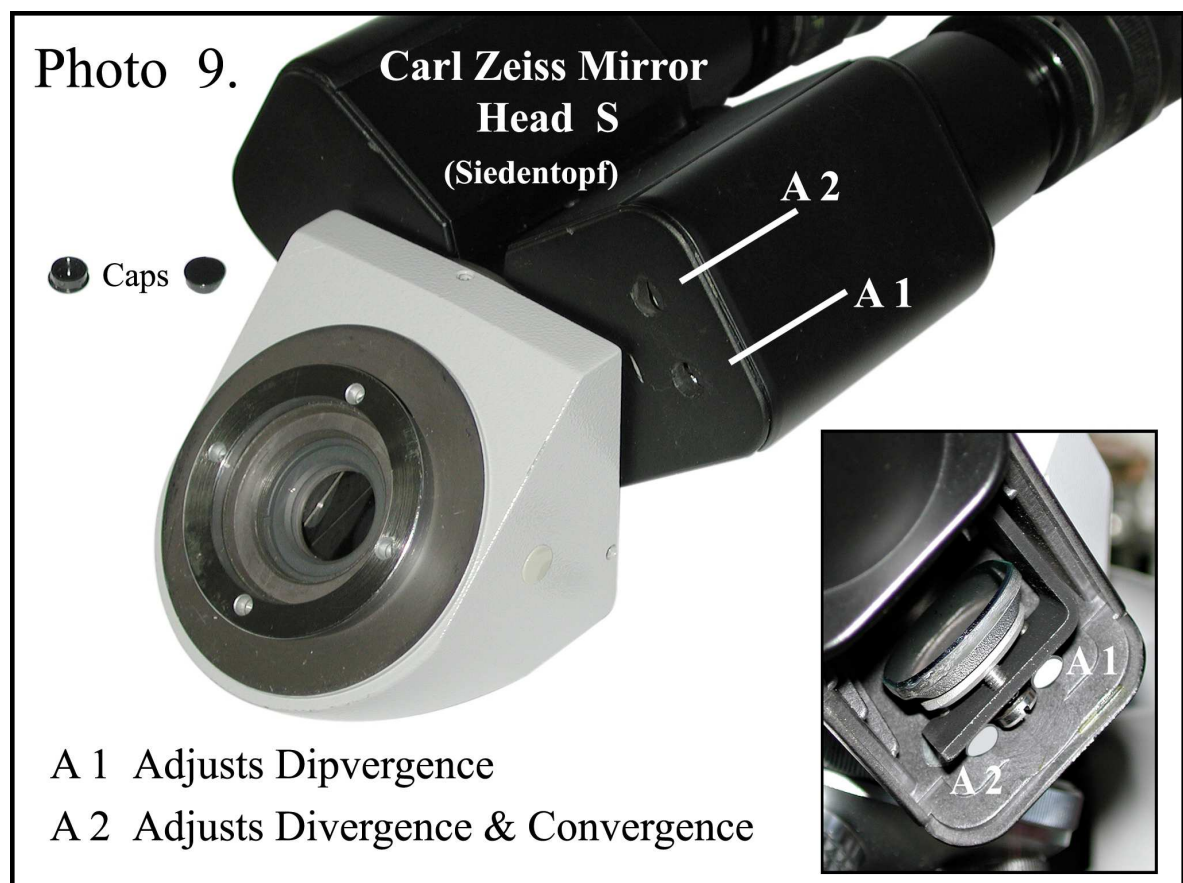


**Photo 9.**

Carl Zeiss (Mirror) Head...Type Siedentopf.

Adjust mirror on right side.

Comments. With this head, Zeiss has made provision for the collimation to be adjusted using two screws bearing on a first surface angled mirror in the right eyepiece box. If you look under this box you will see two small plastic plugs, remove these (thumb nail only please) to gain access to the said screws. Now, when you sit facing the microscope the screw in the top hole adjusts Dipvergence, and the screw in the bottom hole Divergence and Convergence.



Use your screwdriver with care, a fraction of a turn has a noticeable effect, which of course you will see as you observe the collimation progress through the 10 x (cross line) eyepiece. Please note, the side cover plate was only removed (as shown in Photo 9) to display the mirror that is moved by these screws during the collimation process, and it is not a requirement when adjusting the binocular head. In addition, do not forget to replace the plastic plugs when you have finished.

Difficulty level...Easy and straight forward.

### **Testing your handy work.**

When you have completed the collimation process, your handy work needs to be crosschecked but in a different way, (using 'blink comparison'). The following test is very searching, take a spread slide like I mentioned earlier (fine sand, forams etc) and focus the slide using a 10x objective (4x if the sand or forams are coarse) and a matched pair of 10x eyepieces. Then study the edge of the field diaphragms in each eyepiece, looking North, East, South and West, and noting where the subject matter is bisected, if the sight picture in your binocular head is identical in both eyepieces when you 'blink' between the two, then you have achieved collimation. If not rotate, the eyepieces to check they are not introducing errors for they may not be matched pairs, (although with today's manufacturing it is seldom a problem). If the collimation is still out, go back to step one because you have not been as careful as you thought! ...Not to worry try again, you will get better with practice.

Finally, if you have taken care when performing the systematic instructions your resulting accuracy of collimation will equal the original manufacturer's tolerances. Oh and by the way, welcome to the world of D.I.Y. microscope servicing.

### **Addendum**

After the above article was published by the Manchester Microscopical and Natural History Society I received a great many e-mails asking "could I recommend a few books for further reading on the subject of binocular collimation"...Well, I am afraid that was quite a tall order for information is sparse to say the least. In the nineteen fifties, one G. D. Hanna, California

Academy of Sciences, San Francisco, wrote an excellent article in a Scientific American publication entitled 'The Overhaul and Adjustment of Binoculars'. Even though Hanna did not cover binocular microscopes as such, that said, his article was still of great value in the respect of collimation and allied topics.

So, other than the above and an occasional paragraph or two found in microscope service manuals, as far as I am aware there are no in depth guides to collimation for microscopists or anyone else. Unfortunately, this is one-subject that most authors writing on microscope construction appear to avoid like the plague. In fact, there exists a fog of silence surrounding binocular microscope collimation, which I hope this article has helped blow away.

**Ron Green, Rotherham, England.**  
**28<sup>th</sup> November 2008**

#### **Disclaimer**

**Any person or persons undertaking collimation adjustment of any microscope do so entirely at their own risk. The author accepts no liability for financial loss, damage or injury caused by following any advice or instructions given or implied in this article.**

The author would like to thank the organisers of the  
Internet Archive Library for the invaluable service  
they provide for historical research.

*Ron Green*